FEDERAL PUBLIC SERVICE COMMISSION

COMPETITIVE EXAMINATION-2024 FOR RECRUITMENT

TO POSTS IN BS-17 UNDER THE FEDERAL GOVERNMENT

Roll Number

PHYSICS PAPER-II

TIME ALLOWED: THREE HOURS **PART-I(MCQS): MAXIMUM 30 MINUTES**	**PART-I (MCQS) MAXIMUM MARKS = 20** **PART-II MAXIMUM MARKS = 80**

NOTE: (i) **Part-II** is to be attempted on the separate **Answer Book.**

(ii) Attempt **ONLY FOUR** questions from **PART-II. ALL** questions carry **EQUAL** marks.

(iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.

(iv) Candidate must write Q. No. in the Answer Book in accordance with Q. No. in the Q. Paper.

(v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.

(vi) Extra attempt of any question or any part of the attempted question will not be considered.

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Roll Number

PHYSICS, PAPER-II

TIME ALLOWED: THREE HOURS	(PART-I MCQs)	MAXIMUM MARKS: 20
PART-I (MCQs) : MAXIMUM 30 MINUTES	(PART-II)	MAXIMUM MARKS: 80

NOTE: (i) First attempt **PART-I (MCQs)** on separate **OMR Answer Sheet** which shall be taken back after **30 minutes.**
(ii) **Overwriting/cutting of the options/answers will not be given credit.**
(iii) There is **no negative** marking. All MCQs must be attempted.

PART-I (MCQs)(COMPULSORY)

Q.1. (i) Select the best option/answer and fill in the appropriate Box ■ on the **OMR Answer Sheet.(20x1=20)**
(ii) Answers given anywhere else, other than OMR Answer Sheet, will not be considered.

1. **A Gaussian surface in the form of a cylinder of radius *R* immersed in a uniform electric field with the cylinder axis parallel to the field. What is the flux of the electric field through this closed surface?**
(A) Zero (B) EA (C) 2EA (D) None of these

2. **Differential form of Gauss's law in magneto statics is:**
(A) div B = μ_0J (B) div B = 0 (C) div B = -dB/dT (D) None of these

3. **Which of the following is the correct expression for the group velocity?**
(A) $\frac{d\omega}{dv}$ (B) $\frac{dE}{dK}$ (C) $\frac{dE}{\hbar dK}$ (D) None of these

4. **The Eigen value of a particle in a box is**
(A) L/2 (B) $\sqrt{2/L}$ (C) $\sqrt{L/2}$ (D) None of these

5. **The probability of finding an electron is uniform in every direction is in which orbital?**
(A) s (B) p (C) d (D) None of these

6. **The degeneracy of the state having energy $\frac{27\hbar^2}{8mL^2}$ for a particle in a three-dimensional cubic box of length L is:**
(A) 4 (B) 3 (C) 2 (D) None of these

7. **In an electromagnetic wave in free space, the root mean square value of the electric field is 6 V/m. The peak value of the magnetic field is:**
(A) 2.83×10^{-8} T (B) 1.51×10^{-8} T (C) 0.80×10^{-8} T (D) None of these

8. **An alpha particle having energy 5MeV entering the proportional counter with capacity of 25 pf. The ionization potential will be ~ 15 eV. The resultant pulse height will be close to:**
(A) 2.1 mV (B) 4.3 mV (C) 6.3 mV (D) None of these

9. **A parallel plate capacitor is charged by connection to a battery. If the battery is disconnected and the separation between the plates is increased, what will happen to the charge on the capacitor and the voltage across it?**
(A) Both increase (B) The charge increases and the voltage decreases
(C) The charge remains fixed and the voltage increases (D) None of these

10. **A hollow metal sphere of radius R is positively charged. Of the following distances from the centre of the sphere, which location will have the greatest electric field strength?**
(A) 0 (centre of the sphere) (B) 3R/2 (C) 2R (D) None of these

11. **Two parallel conducting plates are connected to a constant voltage source. The magnitude of the electric field between the plates is 2,000 N/C. If the voltage is doubled and the distance between the plates is reduced to 1/5 the original distance, the magnitude of the new electric field is:**
(A) 1,600 N/C (B) 2,400 N/C (C) 20,000 N/C (D) None of these

12. **An isolated capacitor with air between its plates has a potential difference V_0 and a charge Q_0. After the space between the plates is filled with oil, the difference in potential is V and the charge is Q. Which of the following pairs of relationships is correct?**
(A) Q = Qo and V > Vo (B) Q = Qo and V < Vo (C) Q > Qo and V = Vo (D) None of these

13. **A positive charge of 3.0×10^{-8} C is placed in an upward directed uniform electric field of 4.0×10^4 N/C. When the charge is moved 0.5 meter upward, the work done by the electric force on the charge is:**
(A) 6×10^{-4} J (B) 12×10^{-4} J (C) 2×10^4 J (D) None of these

14. **A conducting sphere of radius R carries a charge Q. Another conducting sphere has a radius R/2 but carries the same charge. The spheres are far apart. The ratio of the electric field near the surface of the smaller sphere to the field near the surface of the larger sphere is most nearly to:**
(A) 1/2 (B) 2 (C) 4 (D) None of these

15. **If the only force acting on an electron is due to a uniform electric field, the electron moves with constant:**
(A) Acceleration in the direction opposite to that of the field (B) Acceleration in the direction of the field
(C) Speed in a direction opposite to that of the field (D) Speed in the direction of the field

16. **An ion with charge q, mass m, and speed *v* enters a magnetic field B and is deflected into a path with a radius of curvature R. If a second ion has speed 2*v*, while m, q, and B are unchanged, what will be the radius of the second ion's path?** (A) 4R (B) 2R (C) R/2 (D) None of these

17. **The Ampere law is based on which theorem?**
(A) Green's theorem (B) Gauss divergence theorem (C) Stoke's theorem (D) None of these

18. **A nucleus of $^{235}_{92}U$ disintegrates to $^{207}_{82}Pb$ in about a billion years by emitting 7 alpha particles and x beta particles, where x is:**
(A) 3 (B) 4 (C) 5 (D) None of these

19. **Two identical coaxial coils P and Q carrying equal amount of current in the same direction are brought nearer. The current in:**
(A) P increases while in Q decreases (B) Q increases while in P decreases
(C) Both P and Q increases (D) Both P and Q decreases

20. **In an electromagnetic wave, the electric field of amplitude 6.2 V/m oscillates with a frequency of 2.4 X 10^{10} Hz. The Energy density of the wave is:**
(A) 1.4×10^{-10} J/m^3 (B) 2.4×10^{-10} J/m^3 (C) 3.4×10^{-10} J/m^3 (D) None of these

PART-II

NOTE:
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(iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.
(iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.
(v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.
(vi) Extra attempt of any question or any part of the question will not be considered.
(vii) **Use of calculator is allowed.**

Q. 2. **(a)** Derive the work-energy theorem of electrodynamics (Poynting theorem) and discuss the Poynting vector. **(10)**
(b) What is magnetic vector potential? Also compare magnetic vector potential and electric scaler potential. **(05)**
(c) Find the magnetic field a distance z above the center of a circular loop of radius R, which carries a steady current I. **(05) (20)**

Q. 3. **(a)** What are the limitations of Gauss's Law? How it can be applied on a material with bound charges(dielectrics)? **(10)**
(b) The long solenoid has 220 turns/cm and carries a current i =1.5 A; its diameter D is 3.2 cm. At its center we place a 130-turn closely packed coil C of diameter d =2.1 cm. The current in the solenoid is reduced to zero at a steady rate in 25 ms. What is the magnitude of the emf that is induced in coil C while the current in the solenoid is changing? **(05)**
(c) Calculate the Curl of electric field **E.** **(05) (20)**

Q. 4. **(a)** Briefly discuss the phenomenon of Photoelectric effect. Deduce the value of Plank's constant using concepts of stopping potential and work function. **(10)**
(b) X rays of wavelength λ=22 pm (photon energy=56 keV) are scattered from a carbon target, and the scattered rays are detected at 85° to the incident beam. What is the Compton shift of the scattered rays? **(05)**
(c) Describe the significance of a nearby nucleus in the process of pair production. Why is it necessary for the phenomenon to take place? **(05) (20)**

Q. 5. **(a)** Explain the splitting of energy levels of atoms in external magnetic field based on the quantum theory by considering the spectral lines of sodium. **(10)**
(b) Discuss the momentum and energy operators in quantum mechanics and write down the significance of these operators. **(05)**
(c) Show that the particle in one dimensional box can only have discrete energy values. **(05) (20)**

Q. 6. **(a)** How the energy levels in the crystalline solids form the energy bands? Differentiate between metals and semiconductors bases on the band gap pattern and electrical properties of the solids. **(10)**
(b) How many conduction electrons are in a cube of sodium $^{23}_{11}Na$ of volume $2 \times 10^{-6} m^3$. Sodium atoms are monovalent. Density and molar mass of sodium are 0.968 g/cm^3 and 22.98 g/mol respectively. **(05)**
(c) What is a Bravais lattice? Write down types of Bravais lattice in three-dimensional space. **(05) (20)**

Q. 7. (a) How radiations are detected? Discuss any two radiation detectors in detail. (10)

(b) Explain working principle of the cyclotrons and synchrotrons. (05)

(c) Suppose a cyclotron is operated at an oscillator frequency of 12 MHz and has a dee radius R = 53 cm. What is the magnitude of the magnetic field needed for deuterons to be accelerated in the cyclotron? The deuteron mass is $m = 3.34 \times 10^{-27}$ kg (twice the proton mass). What is the resulting kinetic energy of the deuterons? (05) (20)

Q. 8. (a) Discuss the working principle and applications of MOSFET. (10)

(b) What is the probability that a quantum state whose energy is 0.10 eV above the Fermi energy will be occupied? Assume a sample temperature of 800 K. (05)

(c) Graphically show the occupancy probability and density of states as a function of energy. (05) (20)

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